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# User-needs based app for patients with inflammatory bowel disease: development and usability study

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## Abstract

**Background** As digital healthcare solutions evolve, mobile applications (apps) have become essential tools for managing chronic conditions. Inflammatory Bowel Disease (IBD), including Crohn's disease and ulcerative colitis, is a chronic, rare disease that requires lifelong management. Mobile apps can help IBD patients by providing tools for self-monitoring and improving shared decision-making with healthcare professionals.

**Objective** This study aimed to develop a digital healthcare app specifically designed to meet the unique needs of IBD patients. The app sought to enhance self-management capabilities while improving the quality of communication between patients and healthcare providers through comprehensive usability evaluations.

**Methods** The study followed a four-step process: (1) Design of six core features based on patient needs and expert feedback; (2) Development of the app's architecture, database, and interface as an initial concept version, followed by testing and deployment; (3) Heuristic evaluation with 15 experts, a four-week usability test with 20 IBD patients, and focus group interviews to gather feedback; and (4) Refinement and upgrade of the app to version 1.0 based on usability test results and further feedback.

**Results** The results of this study followed these steps: 1. Incorporating feedback from IBD patients and experts, the core features of the app were designed to include a Personalized Health Summary, Symptom Tracking, and Medication Adherence Monitoring using Patient-Reported Outcomes (PROs). 2. A prototype version of "WITH-Jang" was developed, integrating these key features and undergoing initial testing. 3. Usability testing was conducted with 15 experts and 20 IBD patients to assess effectiveness and identify areas for improvement. 4. Based on the evaluation results, the app was refined with a simplified and intuitive UI and an updated "My Health Summary" page, leading to the release of WITH-Jang 1.0.

**Conclusions** The WITH-Jang app supports proactive self-health management by addressing the core needs of IBD patients. It visualizes symptom and medication data and enhances communication between patients and healthcare providers, enabling personalized care and shared decision-making, making it a valuable tool for chronic disease management.

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## Introduction

A growing need for efficient healthcare management has led to an increasing emphasis on digital healthcare solutions, as conditions requiring long-term care pose significant challenges for the healthcare industry, highlighting the importance of effective strategies for managing chronic diseases globally [1]. Particularly, mobile healthcare applications (apps) have advantages in terms of integrated healthcare services due to their portability and instant accessibility, playing an essential role in chronic disease management [2]. These apps contribute to patient self-management by enabling them to effectively manage symptoms and treatments while enhancing their health knowledge [3].

Inflammatory Bowel Disease (IBD), which includes Crohn's disease (CD) and ulcerative colitis (UC), is characterized by recurring periods of relapse and remission. It is a chronic, rare, incurable disease and requires lifelong management [4]. Globally, 4.9 million people are affected by IBD, and in South Korea, the prevalence has been steadily increasing over the past decade, with rates of 36.9 per 100,000 for CD and 65.7 per 100,000 for UC [5]. Although the exact causes of IBD remain unknown, abnormal immune responses to specific triggers are thought to result in chronic intestinal inflammation, leading to unpredictable and prolonged symptoms [6]. This condition reduces patients' quality of life, negatively affecting social and interpersonal relationships [7] and leading to feelings of helplessness and low self-esteem [8].

IBD is a lifelong disease characterized by cycles of remission and relapse. Current treatments primarily focus on managing symptoms, preventing relapse, maintaining remission, and improving patients'quality of life. Given that the disease mainly affects individuals in their 20 s and 30 s, mobile healthcare apps provide IBD patients with valuable tools for self-monitoring and health improvement [9]. These apps also support healthcare providers in personalizing patient care and achieving better health outcomes. The mHealth app market is projected to grow from $80.87 billion in 2023 to $861.4 billion by 2030, with a compound annual growth rate (CAGR) of 40.2% during this period [10]. Health apps, as a key medium in mHealth, have become primary channels through which users access healthcare support and information more conveniently. Notably, 65.9% of internet users choose health apps for managing their health. From a user perspective, these apps offer advantages such as cost efficiency, convenience, and enhanced access to health information, overcoming geographic limitations. Additionally, the use of patient-reported outcomes (PROs) via these apps enables personalized health management and contributes to improving the quality of life for service users, driving further demand [11].

mHealth for effective management of chronic rare diseases includes the use of technology to facilitate communication between healthcare consumers and providers. It allows tracking health-related information, monitoring symptoms, and providing a platform for answering patient queries. In the context of IBD, the use of digital healthcare, particularly mobile apps, is becoming increasingly important for managing symptoms and treatments. Most IBD apps offer features such as symptom tracking, diet management, exercise logs, patient education, and communication tools with healthcare professionals. Several studies have shown that digital health apps help in managing IBD symptoms, reducing hospital visits, and improving patients'quality of life [12]. These apps enable patients to voluntarily and continuously monitor their health and take immediate actions when necessary. However, while the contents of these apps vary and some lack scientific evidence or up-to-date information, making the delivery of reliable and accurate information a crucial factor in the evaluation of these apps [13].

Digital health applications have become vital tools in managing IBD, and their clinical utility has been widely recognized [12]. However, to maximize the long-term benefits of these applications and solidify their role as practical patient management tools, it is essential to develop optimized designs that reflect the needs of both patients and healthcare providers. This requires an approach in which the development process actively involves feedback and participation from both parties.

Many existing mobile applications for inflammatory bowel disease (IBD) lack core features such as patient-reported outcomes (PROs), personalized feedback, and communication pathways with healthcare providers. These apps are often developed without user-centered design principles or co-design approaches involving both patients and healthcare professionals. A systematic review reported that most IBD apps lack professional medical involvement, PRO-based features, and real-time communication channels with clinicians [14]. Another narrative review highlighted that although telemedicine rapidly expanded during the COVID-19 pandemic, disparities in digital access and patients' technological proficiency remain significant barriers. The authors emphasized that remote care solutions must consider individual users' willingness and capabilities to engage

with digital health technologies [15]. Furthermore, recent global findings indicated that although various PRO collection tools have been developed, structural integration of this data into clinical decision-making remains insufficient [16].

Consequently, there is a continued demand for user-participatory applications that reflect real clinical needs and support shared decision-making between patients and providers. Therefore, an unmet need remains for a user-centered digital health solution that addresses these gaps and supports proactive disease management.

To respond to this need, the WITH-Jang app was designed based on co-creation workshops with both patients and clinicians. The app incorporates features such as symptom tracking, medication adherence visualization, and personalized health summary reports. These components were developed in alignment with internationally recognized clinical indicators (e.g., Mayo Score, CDAI) and aim to address common self-management challenges faced by IBD patients globally, enhancing the app's potential for international scalability and adaptation.

This study aims to develop a digital healthcare application tailored to the specific needs of IBD patients. By conducting usability evaluations, we seek to assess the feasibility and acceptability of the app and establish a foundation for continuous and proactive digital health management. Ultimately, the goal is to enhance patients'self-management capabilities, empowering them to take more control over their health outcomes.

## Methods

### Study design

The progress of this study is presented in (Fig. 1). Co-design, also referred to as user-centered design, involves a collaborative approach between developers and users throughout the design process and aims at refining the process by eliciting user requirements. This methodology is particularly critical during the development phases of health-related applications [17]. In this study, the key functionalities derived from the requirements of users (IBD patients) through a user-centered design approach were integrated from the outset of the mobile app development process.

#### *STEP 1. Prototype Design*

In the preliminary study, five key features of a digital healthcare app were identified based on user requirements through a Co-Creation Workshop (CCW) involving eight IBD patients, one UX designer, one nursing and

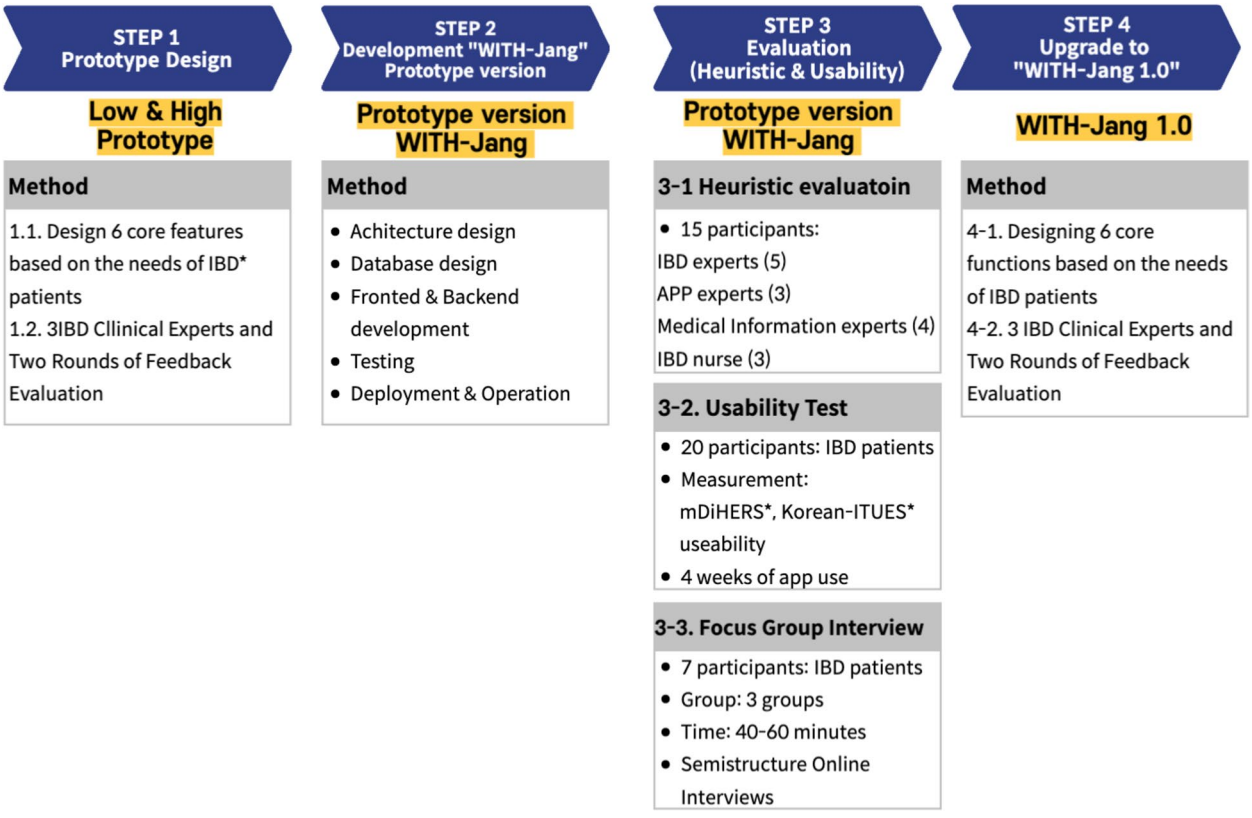


**Fig. 1** Research process IBD: Inflammatory Bowel Disease; mDiHERS: Mobile-Centered Digital Health Readiness Scale: Health Literacy and Equity Scale; Korean Health-ITUES: Korean Version of the Health Information Technology Usability Evaluation Scale;

health informatics expert, and two nursing research specialists. The key features identified were A. Personalized symptom management, B. Simple and easy recording, C. Reliable Information, D. Alarm (Reminder), E. Communication between IBD patients [18]. Additionally, a sixth feature was incorporated based on user feedback—the desire for effective utilization of personal health data ("Use of my information"). These six features were applied during the design phase of the digital healthcare app for IBD patients, shaping both the menu and the functionality.

The selection of the app's core components was not arbitrary, but grounded in both user input and prior evidence. During the co-creation workshop, IBD patients and healthcare professionals collaboratively identified significant challenges in daily disease management, such as difficulties in remembering medications, understanding symptom triggers, and communicating health status during clinical visits. As a result, key features such as symptom tracking, medication reminders, and health summary reports were prioritized. These features are also commonly emphasized in prior literature on IBD self-management apps [12, 13, 24], supporting their inclusion not only from a user experience standpoint but also from a research-informed perspective.

The UI of the digital healthcare mobile app for IBD patients was developed to enhance the user experience and facilitate effective two-way communication with healthcare providers. Both low-fidelity and high-fidelity prototypes were created, and feedback from IBD clinical experts was obtained twice throughout the process, leading to the development of the final functionality and UI. In this study, *low-fidelity prototypes* refer to rough and straightforward wireframes or sketches that illustrate the basic structure and layout of the app without detailed design elements. In contrast, *high-fidelity prototypes* represent visually refined and interactive mock-ups that closely resemble the final user interface and include realistic content, functions, and navigation flow.

1–1. First, based on the six key features derived from user requirements, a low-fidelity UI was developed by an informatics researcher and three nursing science specialists. The first round of feedback was obtained from three IBD clinical experts. Feedback was gathered through two rounds of evaluation, using semi-structured interviews conducted via Zoom online meetings. In the first round of feedback, a quantitative suitability assessment was performed, where each of the six core features was rated on a scale from 1 (very inappropriate) to 5 (very appropriate). Additionally, a qualitative assessment was conducted using three main questions regarding the strengths, weaknesses, and potential revisions for each feature.

1–2. After revising the prototypes based on the first round of feedback, high-fidelity prototypes were developed. The final version of the UI and functionality reflected the results from both rounds of feedback. For the second round of evaluation, the low-fidelity UI was revised and implemented as an APK (application package) file, which was sent to the evaluators via email in advance. The second round followed the same format as the first, with a 1:1 Zoom interview lasting approximately one hour. The interview focused on the app's design, tone and manner, efficiency, user preferences, and potential further modifications.

#### *STEP 2. Development of the WITH-Jang Prototype version*

The architecture and infrastructure of the digital healthcare app for IBD patients were designed and developed to provide a foundation for digital health management and research, while ensuring adaptability for change in management and scalability. The database was structured to accommodate health management data and detailed health information reporting, considering the overarching themes of interrelated services for both IBD users and clinical experts. To ensure data security and usability, the app utilizes an EC2-based containerized API service controller from the Amazon Cloud Server System, providing flexibility in standardized code management and resource allocation.

During the app development process, the mobile app's structure and data model were defined with consideration of client–server interactions, allowing for the safe storage and processing of collected data. Additionally, the app was designed to incorporate user feedback promptly and to continuously expand its functionality based on research outcomes and evaluations from healthcare professionals. This approach ensures the delivery of more efficient health management services to users while providing precise data to medical experts (Fig. 2).

#### *STEP 3. Evaluation*

**Heuristic Evaluation for Experts** To identify usability issues of the app in advance, 15 experts were recruited (5 IBD clinical experts, three app specialists, four medical informatics experts, and 3 IBD nurses). The clinical experts were physicians with research or treatment experience related to IBD patients, and the app specialists were developers with expertise in designing and developing health-related apps. Convenience sampling and snowball sampling methods were used for recruitment.

Heuristic evaluation is a method that leverages the expertise of specialists to detect visible usability issues in UI design [19], propose solutions, and prioritize these

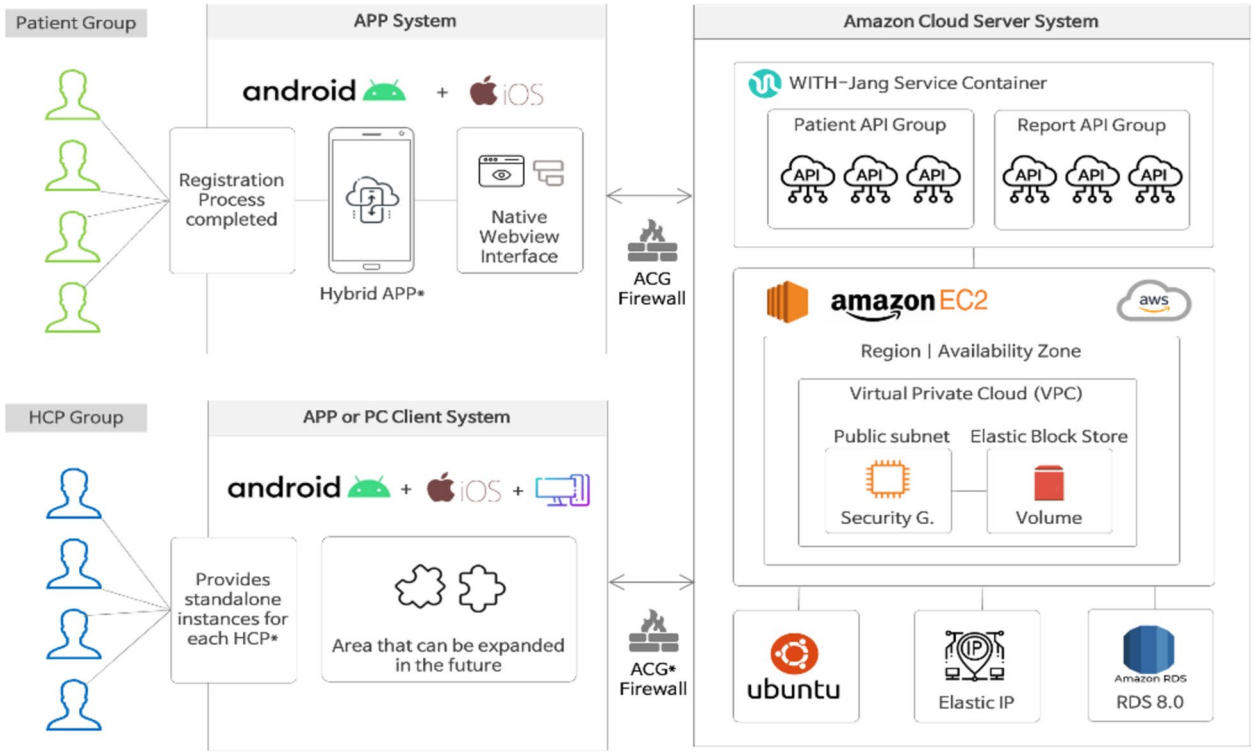


**Fig. 2** Application System Framework. APP: Application; HCP: Health Care Provider; ACG: Application Control Gateway;

issues. This evaluation was conducted to enhance the core functionality and stability of the IBD digital healthcare app. The evaluation process involved downloading WITH-Jang 1.0 from the Android and App Store, using the app with a focus on its core functions, and then assessing the app.

The evaluation tool was based on Joyce's (2016) expert heuristic evaluation (12 items) [20] and was conducted via an online survey using Google Forms. Joyce's tool is one of the most recently published empirical evaluation tools for medical apps, distinguishing itself from other heuristic evaluations by marking each item with the term SMART (smartphone heuristics). The severity of each problem was assessed using a scale developed by Sauro, ranging from 0 to 3, where 0 indicates no discomfort, 1 indicates minor hesitation or annoyance, 2 indicates moderate interference that may cause failure in specific tasks, and 3 indicates severe disruption that leads to task failure. Lower scores indicate less severe usability issues, while higher scores signify more functional problems that impede app use. Additionally, each item allowed for open-ended responses where participants could provide feedback on issues, improvements, and suggestions.

**Usability evaluation of app users** The study participants were IBD patients, and before participating in the study, the researcher explained the purpose and procedures of the study in person and obtained voluntary written consent. Participants who agreed to take part in the study completed a pre-survey to assess their digital readiness and used the digital healthcare app, WITH-Jang prototype version, for four weeks. Usability evaluation was conducted after the app usage, using the Korean Health Information Technology Usability Evaluation and small group interviews. A link to the Google survey was sent via the WITH LAB Kakao-Talk channel to encourage voluntary participation from users. Only participants who completed the survey received a nominal participation fee.

All surveys were consistently structured, and participants were asked for their consent to participate in small group interviews after the survey. The interviews were conducted online, consisting of questions related to the usability survey and their experience using the app.

### Participants

The study participants were (1) adults aged 19 years or older, (2) individuals diagnosed with ulcerative colitis or Crohn's disease, and (3) individuals capable of using mobile devices. Those who were unable to understand the study information or use mobile devices were excluded.

### Assessment tools

#### *Digital readiness (mDiHERS)*

To assess the readiness of individuals to actively engage in digital health services for self-management of their

health, the Development and Validation of a Mobile-centered Digital Health Readiness: Health Literacy and Equity Scale (mDiHERS) was used as a comprehensive tool [21]. This scale includes components of health literacy and equity to ensure the effective use of digital health services, including mobile apps. The questionnaire is composed of the following sections: Mobile Services Capability (10 items), mHealth Literacy: Understand and Utilize Mobile Health Apps and Devices (6 items), Perception of the Importance of mHealth Apps and Devices (3 items), Digital Health Equity (5 items), Characteristics Related to Digital Readiness (5 items), and User's Characteristics (7 items).

The total score for digital readiness is calculated as the average score across the four domains, excluding characteristics related to digital readiness and user characteristics. Scores range from 1 to 5, with higher scores indicating greater readiness for using digital health services. In the mDiHERS study, the Cronbach's α coefficient was reported from 0.84 to 0.91, while in this study, the Cronbach's α coefficient was 0.796.

#### *Korean-health ITUES*

The tool is designed to evaluate the usability of health-related apps and systems, with a particular focus on user experience. ITUES was initially developed to assess the usability of digital health tools, such as mHealth apps, and the Korean version allows for usability evaluation targeting Korean-speaking users. The Korean version of the Health Information Technology Usability Evaluation Scale (Korean Health-ITUES) was used to assess app usability [22]. It consists of 20 items, with higher scores indicating greater usability. Each item is rated on a 5-point Likert scale, ranging from"strongly disagree"(1 point) to"strongly agree"(5 points). The scale is divided into four subdomains: effectiveness (3 items), perceived usefulness (9 items), perceived ease of use (5 items), and user control (3 items). In the study by Lee and Schnall [17], the Korean Health-ITUES showed a Cronbach's α coefficient of 0.951, while in this study, the Cronbach's α was 0.950.

#### *Focus group interview after app usage*

To facilitate in-depth discussions on the topic, focus group interviews were conducted with selected participants. Although the small sample size in focus groups may limit the representativeness of the findings, this method allows for free exchange of opinions and in-depth discussion among expert participants on specific topics [23]. The size of the focus group can vary depending on the research objectives and subject matter, but typically consists of 5–10 members per group, and theoretical saturation can be reached with 2–3 groups [24]. Based on this, in this study, focus group interviews were conducted with three groups, each consisting of 2–3 users who voluntarily agreed to participate after using the mobile healthcare app for four weeks. The interview questions were designed for this study and have not been previously published elsewhere. The interview questions have been uploaded as a supplementary file.

#### *STEP 4. Upgrade to WITH-Jang 1.0*

Based on the expert heuristic evaluation, usability assessment from 20 app users (IBD patients), and FGI results, the app was updated to WITH-Jang 1.0. The heuristic evaluation focused on addressing issues identified through an in-depth analysis of the app's interface and functionality by experts. Additionally, the app was tested in real-world user environments, leading to updates that improved the user interface, optimized functionality, and enhanced accessibility.

### Ethical considerations

This study was approved by the Institutional Review Board (IRB) of Severance Hospital, Yonsei University Health System, Seoul, Republic of Korea (IRB No. 4–2023-1147), and all participants provided written informed consent before participation. Furthermore, the study was conducted in accordance with the ethical guidelines set forth by the Declaration of Helsinki. Before conducting the study, all participants were provided with an explanation of the study, and informed consent was obtained prior to participation. All research-related data were collected solely for this study, and all information gathered from the participants was securely stored in encrypted files, accessible only by the principal investigator and authorized research team members. This study was registered with the clinical trial number KCT0010068 on December 19, 2024. The processed research data files were stored in a cloud database managed by the principal investigator, with access restricted to approved research team members only. This research was supported by the National Research Foundation of Korea (No.NRF-2021R1C1C1004505).

This study adheres to the mHealth Evidence Reporting and Assessment (mERA) checklist, developed by the WHO mHealth Technical Evidence Review Group, to enhance transparency and reproducibility in reporting digital health interventions. A completed checklist is available in Supplementary Table S1.

### Statistical analysis

In this study, descriptive statistics were used to evaluate the significance of changes in the measurements before and after app usage, with the mean and standard deviation as the primary metrics of interest. During the focus group interviews, the research team recorded key points,

and the collected interview data were categorized by themes through discussions among the researchers.

## Results

### STEP 1. Prototype design

1-1 The digital healthcare app for IBD patients was designed based on six core functions derived from the needs of IBD patients identified in prior research. The key functions include: A. Personalized symptom management, B. Simple and easy recording, C. Reliable information, D. Alarm (Reminder), E. Communication between IBD patients, and F. Use of my information [18]. Through 26 online and offline meetings with the app development company, the UI/UX was designed to be intuitive and consistent, providing users with the necessary features and information in an easy-to-use manner, based on the needs of IBD patients.

1–2. The final IBD digital healthcare app was named WITH-JANG (where"JANG"in Korean means"intestine"in English), and three clinical experts (JHC, SJK, ESJ) with research experience related to IBD patients evaluated the core functions and UI based on user needs in two evaluation sessions. The results are as follows. The evaluation of core features (n = 3) is as follows. The"Personalized symptom management"feature received a high score of 4.00 (± 0.00), while the"Simple and easy recording"feature scored 4.33 (± 0.58), and the"Reliable information"feature scored 3.33 (± 0.58). Additionally, the"Alarm (Reminder)"feature received the highest score of 4.67 (± 0.57), and the"Communication between IBD patients"feature scored 3.33 (± 0.58). Finally, the"Use of my information"feature was evaluated at 4.00 (± 0.00). Feedback from three experts is as follows: There is a need to add a method to confirm or provide feedback on medication reminders, as some patients may ignore the alarms. Additionally, enabling reliable communication with healthcare providers through PRO data should be considered. Simply displaying symptoms may not provide significant value; therefore, it is necessary to show the benefits that patients can gain clearly.

### STEP 2. Development of the WITH-Jang prototype version

The key features of the digital healthcare app WITH-JANG prototype version, which reflect the core needs of IBD patients, are as follows (Fig. 3). The app includes a communication board for interaction, an alarm setting feature where users can set reminder times, a calendar that provides an overview of inputted symptoms and medications, an easy and simple symptom recording function, a summary page displaying the user's data, and an FAQ section that offers reliable information provided by Korean Association for the Study of Intestinal Diseases.

### STEP 3. Evaluation

#### *Heuristic evaluation for an expert*

The heuristic evaluation conducted by 15 experts (5 clinical experts, 3 IBD nurses, three app experts, and four medical informatics experts) showed that the severity of the 12 items had an average of 0.70 with a standard deviation of 0.60, indicating that usability issues within the app were minor. Among these items, the highest usability issue was 'SMART 4: Overlay indication for key features,' with an average score of 1.07 (SD 1.10), while the lowest was 'SMART 8: Clear navigation path design,' with a score of 0.40 (SD 0.74). The opinions of the 12 experts are summarized in Table 1.

#### *Usability test of app users*

**General characteristics of participants** A total of 20 IBD patients participated in the test and completed the usability evaluation. The general characteristics of the participants are as follows (Table 2). The average age of the participants was 36.15 years, with 40% male and 60% female. The types of IBD diagnosis were UC in 70% and CD in the other 30%. The duration of illness was 1 to 3 years in 35%, 4 to 10 years in 35%, and 11 to 20 years in 30%. A majority of participants (58.8%, or 20 individuals) primarily used digital devices such as smartphones, tablets, and laptops to manage their health and access health information. Among them, 42.3% (11 participants) had experience in using health apps installed on smartphones for digital health management.

The usability evaluation in this study followed an iterative approach. Initial findings from expert heuristic evaluation and user feedback during the prototype phase were used to inform revisions and improvements, which led to the development of the WITH-Jang 1.0 version. Therefore, the usability testing process was not limited to a static, one-time evaluation of a finalized product, but incorporated continuous refinement based on user-centered insights prior to confirming version 1.0.

**Korean-health ITUES** The app usability evaluation was conducted with 20 participants using the Korean-health Information Technology Usability Evaluation Scale (Korean-health ITUES) tool. The evaluation results showed an average score of 73.93 ± 12.05 out of 100 points, which, when converted to a 5-point scale, was 3.70 ± 0.60. Each category score was converted to a 5-point scale and presented as follows:"Impact"scored 3.99 ± 0.74,"Perceived usefulness"scored 3.73 ± 0.62,"Perceived ease

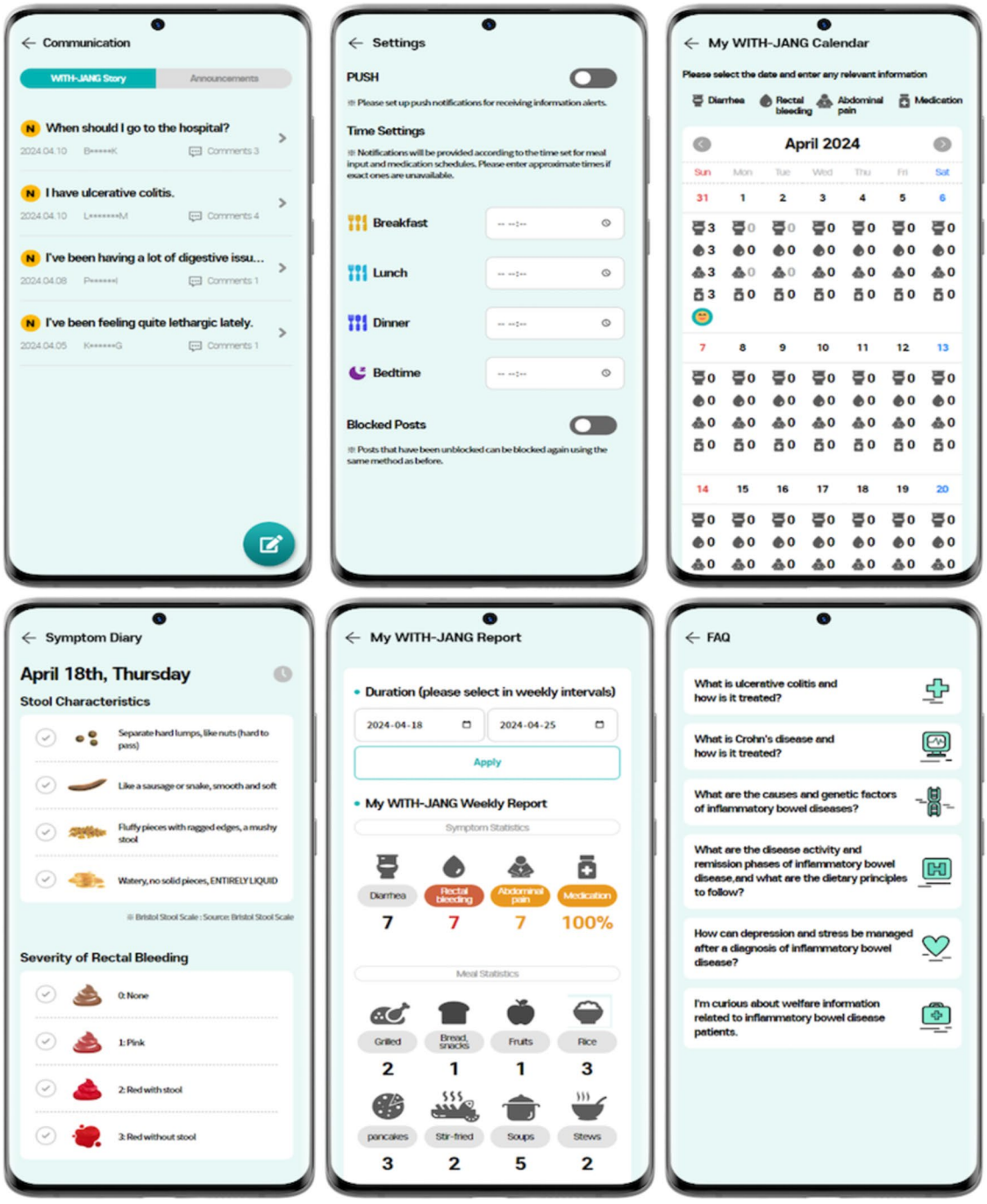


**Fig. 3** Prototype version WITH-Jang

of use"scored 3.73 ± 0.85, and"User control"scored 3.31 ± 0.74.

### *Focus group interview*

The in-depth interview results with seven participants who consented to participate, along with representative quotes, are as follows:

PRO Input Function Participants found the symptom input function to be very helpful.

*"The meal tracking function was the most useful. I could monitor my diet by recording my meals and uploading photos, which gave me a chance to reflect on what I was eating." [App user A, Female, 47].*

*"Since my symptoms change depending on the food I eat, by consistently using the app to track my diet and symptoms, I think I will be able to see which foods trigger certain symptoms." [App user G, Female, 37].*

**Table 1** Opinions gathered through expert-targeted heuristic evaluation ($n = 12$)

| SMART items | mean ± SD | Opinions | Upgrading to WITH-Jang 2.0 |
|---|---|---|---|
| SMART 1: Provides immediate notification of status | 0.60 ± 0.91 | Medication reminders were set, but no notification was received<br>The response time for the notification setting is slow | Apply |
| SMART 2: Use consistent terms with familiar rules and standards | 0.73 ± 0.88 | The user flow is interrupted, and the following action for the user is not connected; a bottom navigation bar needs to be added<br>A simplified layout for the main screen is needed | Apply |
| SMART 3: Prevent problems and resolve problems immediately | 0.80 ± 0.94 | A notification message is needed when the network is not connected<br>There is no support link available for assistance when issues arise while using the app | Do not apply |
| SMART 4: Show overlay for key features | 1.07 ± 1.10 | Add a basic guide feature that explains key functions and how to use them<br>Make essential elements stand out by designing larger buttons and adjusting size, color, and shadow. Use highlighted borders to help users navigate the app more effectively | Partially |
| SMART 5: Focus on 1 task | 0.47 ± 0.83 | The interface is easy to understand because the input screen and the results screen are separated, so it is recommended to maintain the current setup | Apply |
| SMART 6: Visual interface design | 0.73 ± 0.80 | The combination of simple images and concise terminology makes the app easy to use<br>The colors that appear when selecting symptoms are not noticeable enough, so a change is needed | Apply |
| SMART 7:Intuitive interface | 0.80 ± 1.01 | It is necessary to consider whether the simplified format limits the ability to convey users'symptoms more accurately and in detail<br>The landing page lists too many elements, making it difficult to identify the app's core purpose<br>An interface that provides intuitive guidance for the next steps is needed | Apply |
| SMART 8: Clear path to task completion | 0.40 ± 0.74 | The navigation path between each feature and the summary displayed on the calendar needs to be designed more clearly (there was feedback that moving between them is inconvenient) | Apply |
| SMART 9: Allow configuration options and shortcuts | 0.67 ± 0.90 | Consider implementing user-customized feature settings | Do not apply |
| SMART 10: Support for a wide range of mobile environments | 0.73 ± 1.03 | Brightness, sound, and font size can be adjusted directly through the phone's settings<br>The app should be easily usable by users in various mobile environments | Do not apply |
| SMART 11: Ease of input | 0.67 ± 0.98 | It is necessary to consider the ease of viewing the screen that displays the entered results<br>While input is easy, users should be able to record their symptoms in detail, so configuration options to address this need are required<br>When entering medication names, adding text prediction for drug names would improve convenience and usability | Partially |
| SMART 12: Use of cameras, microphones, and | 0.73 ± 1.03 | The current app does not implement this feature | Do not apply |
| Total score | 0.70 ± 0.60 | | |

*"Using the app allowed me to record my symptoms and reflect on them. It made me realize that I need to make more effort, and it got me thinking seriously about managing my own health." [App user F, Female, 29].*

Participants also found the medication diary function to be useful.

*"Sometimes I forget to take my medication, but this app helps me manage my medication schedule, which is really helpful." [App user C, Male, 34].*

*"When I set the medication and reminder times, the app shows a pop-up. This feature keeps reminding me about my medication, which is convenient." [App user B, Female, 35].*

App Usability Users mentioned that the app is handy for patients in active disease stages and has high usability.

*"I really liked the feature that allows you to see all your input data at a glance." [App user B, Female, 35].*

*"The way the app accumulates patient data and allows you to use it is very new and beneficial." [App user D, Female, 23].*

*"This app is great for patients in active stages. It would be even more useful if symptom diaries allowed for more free-form notes and included advice or shared information for psychological support." [App user C, Male, 34].*

**Table 2** General characteristics of usability evaluation (n = 20)

| Characteristics | mean ± SD or n (%) |
|---|---|
| Age | 36.15 ± 8.27 |
| Sex | |
| Male | 8 (40) |
| Female | 12 (60) |
| Clinical type | |
| Ulcerative colitis | 14 (70) |
| Crohn's disease | 6 (30) |
| Duration of illness (year) | |
| 1 ~ 3 | 7 (35) |
| 4 ~ 10 | 7 (35) |
| 10 ~ 20 | 6 (30) |
| Mainly used to manage your health and health information? | |
| Digital devices | 20 (58.8) |
| Broadcasting media | 4 (11.8) |
| Print media | 2 (5.8) |
| Healthcare professionals | 4 (11.8) |
| Social relationships | 4 (11.8) |
| Familiar mobile devices | |
| Smart phone | 19 (61.3) |
| Tablet PC | 4 (12.9) |
| Computer/laptop | 6 (19.4) |
| Wearable device | 2 (6.5) |
| Digital health management services have you tried for health management and acquiring? | |
| Health apps installed on your smartphone | 11 (43.3) |
| Self-installed/downloaded health apps | 2 (7.7) |
| Online lectures/health management programs | 3 (11.5) |
| SNS (Kakao Talk, NAVER BAND, Instagram, etc.) | 7 (26.9) |
| No experience | 3 (11.5) |
| Do you have a willingness to pay for health management and health information services through mobile devices? | |
| No willingness to pay | 9 (45.0) |
| $ 1/month | 4 (20.0) |
| $ 5/month | 5 (25.0) |
| $ 10/month | 2 (10.0) |
| Purchase of mobile devices for health management? | |
| No willingness to pay | 10 (50.0) |
| $ 10 to 50 | 4 (20.0) |
| $ 51 to 100 | 1 (5.0) |
| $ 101 to 150 | 1 (5.0) |
| Over $ 151 | 4 (20.0) |
| mDiHERS Sub-category | |
| A. Mobile services capability (10 items) | 4.77 ± 0.32 |
| B. mhealth literacy: understand and utilize mobile health apps and devices (6 items) | 4.38 ± 0.75 |
| C. Perception of the importance of mhealth apps and devices (3 items) | 4.67 ± 0.50 |
| D. Digital health equity (5 items) | 4.76 ± 0.45 |
| mDiHERS (Total) | 4.64 ± 0.40 |

App Modification Discussion.

> *"For patients in remission, there are no symptoms to input, so the app needs to consider how to increase usability for these patients." [App user A, Female, 47].*

> *"The calendar function is useful, but it needs a more intuitive and simpler design. Also, it could be easier to use—there seems to be too much tapping involved." [App user G, Female, 37].*

#### *STEP 4. Upgrade to WITH-Jang 1.0*

WITH-Jang 1.0 was updated based on the expert evaluation results from STEP 3–1 and the opinions of IBD patients in STEP 3–2 and 3–3 (Fig. 4). The key updates are as follows:

First, in addition to the medication reminder time setting and popup function, the app now automatically calculates the medication adherence rate as a percentage when the user presses the'completed input'button according to their medication schedule.

Second, a'My WITH-Jang Report'page was developed to enable trustworthy communication with medical professionals using the user's data. This page categorizes key items based on the diagnosis set during user registration: for UC patients, diarrhea and bloody stools are highlighted, while for CD patients, diarrhea and pain are summarized and visualized. Furthermore, users can set their health reports to be summarized on a weekly or monthly basis, aligning with their outpatient visit schedules and facilitating more reliable communication between users and healthcare providers based on the self-reported data.

WITH-Jang is an app designed to help users build healthy habits and promote proactive health behavior changes through symptom tracking, medication, and dietary records. The main page was restructured into a more streamlined and intuitive input and summary page. Notably, the meal diary feature, identified as the most helpful function in user evaluations, was enhanced. The app now summarizes the top three most frequently consumed foods based on the user's meal logs and visualizes the associated symptom changes. Through these improvements, WITH-Jang has evolved into an optimal digital healthcare tool to support IBD patients in voluntarily managing their symptoms.

## Discussion

### Principle results

This study developed and evaluated the usability of a digital healthcare app called"WITH-Jang"for patients with IBD, a rare chronic disease. Based on the core user needs identified through preliminary research, the app was developed collaboratively by clinical experts, nurses, app

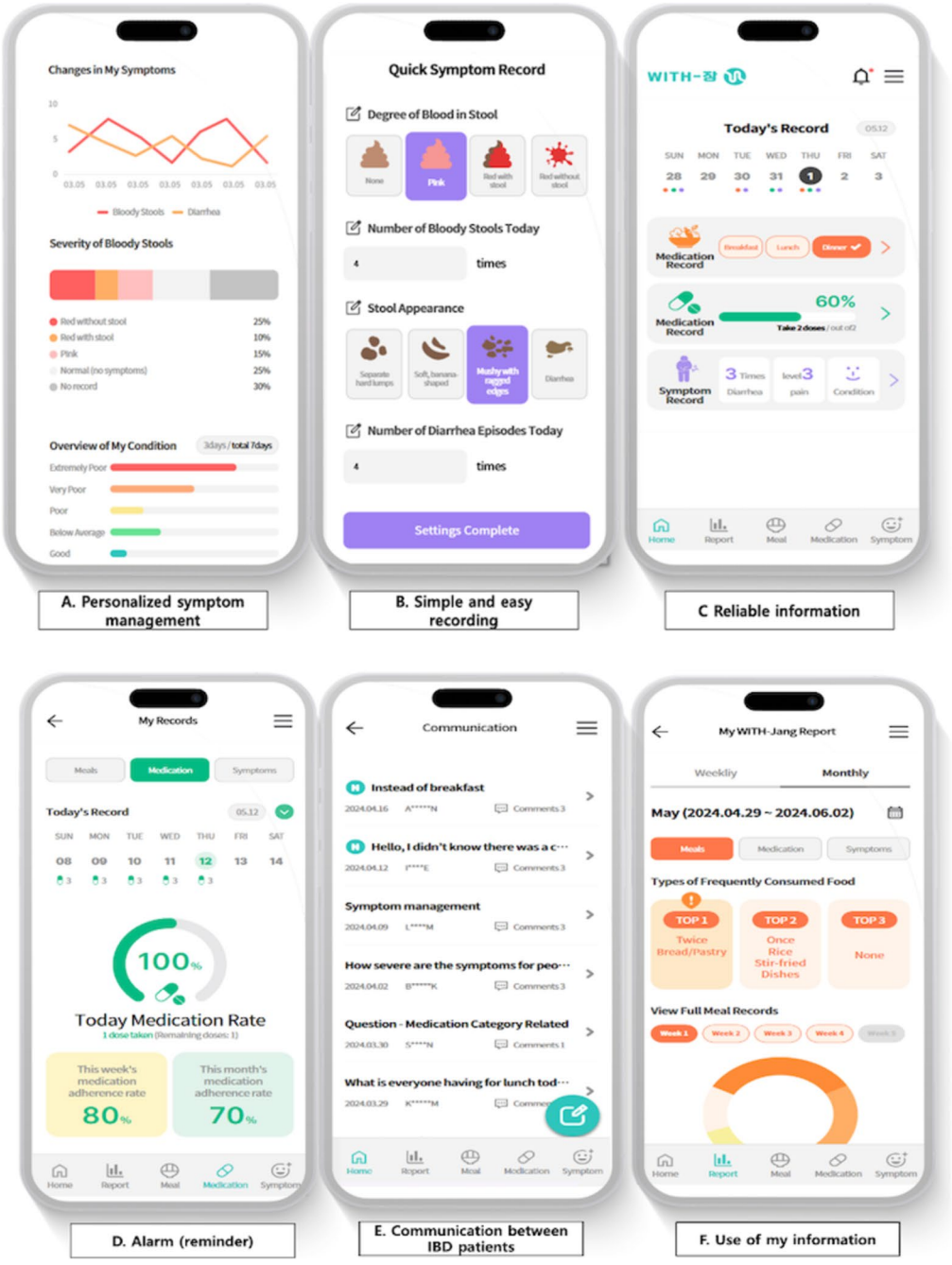


**Fig. 4** WITH-Jang 1.0

developers, and UX designers. It includes customized input screens tailored to those with UC and CD patients, enabling easy recording and intuitive touch features to support active patient self-management. The app's reliability was enhanced through external validation by clinical experts during the design process. Additionally, the app provides personalized health summary reports, such as "My WITH-Jang Report," that incorporate PRO. It also includes a feature to display symptom experiences and medication adherence as percentages based on patient symptom data entered. Additionally, the page was used to facilitate smooth communication with healthcare providers and enable more efficient patient self-management.

Unlike many IBD apps that focus solely on symptom logging, WITH-Jang was designed through a co-creation process with both patients and clinicians, incorporating validated PRO-based features and communication functions. This participatory design ensures the app's alignment with real clinical workflows and patient needs. Moreover, the features of WITH-Jang address core

self-management challenges reported in international IBD literature, suggesting its potential generalizability to diverse populations beyond the local setting.

The core features of WITH-Jang, developed based on user requirements, are as follows: A. Personalized symptom management, B. Simple and easy recording, C. Reliable information, D. Alarm (Reminder), E. Communication between IBD patients, and F. Use of personal information. These functionalities align with those of digital healthcare apps for IBD patients [25, 26]. However, according to studies on systematic analysis and content analysis of mobile apps, there are many apps that generally address IBD, but very few are specialized for Crohn's disease or ulcerative colitis. Notably, most apps are aimed at patients rather than directly targeting physicians [27]. WITH-Jang distinguishes itself by being designed with the needs of both IBD patients and healthcare providers in mind, setting it apart from other apps.

The primary significance of this study lies in developing an app that enables proactive health management through a user-centered design that reflects explicitly the needs of IBD patients. Despite the significant advance in digital healthcare apps, implementing health information technology often fails [28]. Previous research has indicated that the functionality of apps may not align with the needs of end users, and there is frequently a mismatch between how the app is designed to function and how the intended end users expect it to operate [29]. These discrepancies highlight the importance of aligning app functionalities with user expectations to improve adoption and usability.

In this study, the usability of the WITH-Jang app was evaluated using the Korean version of the Health Information Technology Usability Evaluation Scale (Health ITUES), and the average score was 3.70 out of 5.00, indicating a moderate-to-high level of usability. This result is particularly notable when compared to previous studies that evaluated other mHealth applications using either the original or Korean version of Health ITUES. For example, a validation study of the Korean Health ITUES using a menstrual tracking app (PINKDIARY) reported a mean usability score of 3.54 [30], while studies using the original Health ITUES found scores of 3.44 for an HIV medication adherence app [31] and 3.63 for an asthma self-management app [32]. These comparisons suggest that the usability of WITH-Jang is comparable to or better than that of other well-studied digital health applications. This is especially significant given that its target users—individuals with inflammatory bowel disease (IBD)—require long-term, multifaceted self-management support. The findings reinforce the feasibility and user-centered design of the app in the context of chronic and complex disease care.

User-centered design (UCD) is a methodology aimed at making digital healthcare technologies and services more appealing by discovering user experiences, identifying their needs, goals, and preferences, and incorporating them into digital healthcare through collaborative interaction with users to understand their ways of interacting with the technology [33]. The WITH-Jang app, developed based on users'needs, allows patients to manage their health, enabling proactive health management and positive behavioral changes. A CCW was conducted based on a preliminary study that reflected the needs of IBD patients, which helped define the app's core features. This initial study identified six key needs [18], which were then used to determine the app's primary functions. The core needs are: A. Personalized symptom management, B. Simple and easy recording, C. Reliable information, D. Alarm (Reminder), E. Communication between IBD patients, F. Use of my information. Ultimately, this app aimed to improve the quality of life for IBD patients by providing them with the tools they need for proactive self-care.

The intervention developed in this study is composed of several interconnected elements that work together to support patient self-management. These include patient-reported symptoms and medication tracking, visualization of health status, personalized feedback from nurses, and educational content to enhance health literacy and behavior change. Each component is designed to complement the others—for example, symptom tracking enables more relevant and timely feedback, which can in turn improve patient motivation and adherence. Furthermore, the intervention involves collaboration across multiple roles: patients use the app to manage their condition; nurses provide clinical feedback and encouragement based on real-time data; and physicians may use the reported information to inform care decisions. The system also adjusts to individual user needs, such as disease type, severity, and digital literacy, allowing for flexible and context-sensitive use. The combination of these interdependent and personalized features contributes to the complexity of the intervention and should be considered when evaluating its implementation and impact.

UCD, especially when combined with real workflow and the needs of healthcare professionals, can significantly improve the usability and effectiveness of digital healthcare apps [34]. The WITH-Jang involved active participation from both users and healthcare providers at every stage of its development, aligning with previous studies on co-design and participatory design in mHealth. The involvement of healthcare providers offers a unique perspective in the creation of patient-centered digital healthcare, providing key insights into optimizing patient engagement and usability [35]. Notably, the WITH-Jang app integrated nurses, acting as patient

advocates from the early stages of development, ensuring a patient-centered approach. This process enabled the creation of an app that provides end users with meaningful, reliable, and evidence-based health information [34].

Furthermore, continuous engagement from users and healthcare providers is also essential for successfully implementing digital healthcare in real-world environments [36]. The current study incorporated feedback from IBD-related healthcare providers, nurses, and patients from the design stage. After developing version 1.0, usability testing was conducted with 20 IBD patients, and with expert consultation, the app was ultimately updated to WITH-Jang 2.0. This collaborative and iterative approach, which prioritizes user needs and involves healthcare professionals, ensures that the app effectively addresses the needs of IBD patients and enhances both its functionality and potential as a critical tool for patient care.

PRO, which refers to the health status and treatment responses reported directly by the patient, is increasingly recognized as an essential tool for healthcare providers to understand the patient's condition better. More than 80% of clinical practices for IBD treatment currently apply PRO, which has been shown to impact IBD management [37] positively. It has recently emerged as a key element in personalized medicine [29]. However, existing studies have primarily provided generalized PRO data, which limits their app in customized patient management [28].

One of the key assumptions underlying this study is that engaging with the app to input self-reported data—such as symptoms, meals, and medication adherence—can help patients build awareness of their own health status. Over time, this repeated self-reporting is expected to foster healthy habits, promote proactive self-management, and lead to positive behavior changes. These behavioral improvements, in turn, are hypothesized to contribute to better disease control and enhanced health-related quality of life. Especially in the context of a chronic, non-curable condition such as IBD, long-term self-management supported by digital tools can play a crucial role in maintaining stability and improving the patient's overall well-being.

To address this issue, the WITH-Jang app provides a personalized report page,"My WITH-Jang Report (Core Needs: A. Personalized Symptom Management)", based on PRO data entered by patients, including symptoms, abdominal pain, diarrhea, diet, and medication adherence. Symptoms summary and medication adherence are visualized as percentages, enabling patient-centered, data-driven health management. The collaborative approach with patients and healthcare professionals played a crucial role in optimizing the UX, ensuring that PRO data entered by patients was reflected in real-time for communicating with healthcare professionals. During the initial design phase, a prototype was created based on the requirements of patients and healthcare providers, followed by iterative usability testing and feedback to correct functional errors and enhance user convenience. This continuous feedback and evaluation create the app's crucial page, allowing patients to easily monitor their health status and communicate effectively with healthcare providers.

Therefore, the study findings can be used to support the design and functional elements of the app, as they align with global digital health priorities for self-management of chronic diseases. While this study was conducted with a relatively small local sample, the app's core features—symptom tracking, medication reminders, and personalized feedback based on PROs—reflect widely reported needs among IBD patients globally. These findings suggest the app's potential for broader applicability beyond the local context [12, 13, 24].

Furthermore, the app shows a visualized page tailored to the type of IBD the patient has. For UC, it selects input factors from the Mayo Score; for CD, it selects factors from the Crohn's Disease Activity Index that the patient can enter directly. Additionally, regarding UI/UX design, the app maximizes usability through easy data entry and intuitive visualization. This allows users to easily understand their health status and collaborate with healthcare providers to develop a more appropriate treatment plan. Importantly, utilizing clinically useful PROs in digital healthcare apps for the proactive health management of IBD patients is highly significant. It is expected to be an effective communication tool between patients and healthcare providers.

While digital healthcare apps hold the potential to revolutionize personalized health management, additional validation and improvement based on clinical perspectives and patient experiences are required [38]. The WITH-Jang app lets patients easily input their symptoms and enables reliable communication with healthcare providers. This system goes beyond simple symptom monitoring, helping healthcare providers formulate more precise treatment plans based on patient data. Future studies should focus on verifying the long-term clinical outcomes and cost-effectiveness of WITH-Jang, as such findings would serve as essential evidence of the utility of digital healthcare apps in managing IBD and other chronic conditions.

## Conclusions

The digital healthcare app WITH-Jang, designed for individuals with IBD, a chronic and relatively rare condition, encompasses several distinctive features. First, the app's development was grounded in a comprehensive preliminary study that identified the essential needs of IBD patients. This meticulous process ensured the integration of user-centered design principles, making WITH-Jang a powerful tool for empowering patients in their proactive

health management journey. Second, the app is purposefully streamlined to focus on ease of use, with simplified functions and intuitive touch interactions. It enables patients to record symptoms through a tailored interface specific to their diagnosis, fostering personalized health management based on PROs. Third, WITH-Jang was co-developed by healthcare providers and patients, enhancing communication and collaboration within clinical settings. The"My Health Summary"feature visualizes symptom and medication data as easily interpretable percentages, facilitating seamless dialogue between patients and healthcare providers. Through this collaborative design approach, WITH-Jang delivers specialized self-management and individualized care features, establishing itself as a pioneering tool that supports shared decision-making and ultimately enhances the quality of life for patients.

### Limitations

This study had a relatively small number of participants and was conducted as a four-week usability test, further warranting the generalizability of the results. According to the previous review study, the clinical utility of digital healthcare apps is limited, and some apps do not effectively facilitate intervention or adjustment in treatment plans [28]. It would be necessary to verify its effectiveness in real clinical settings through more rigorous study designs, such as large-scale studies or randomized controlled trials. Given these limitations, future research should take a more comprehensive approach to evaluating the long-term usefulness of digital healthcare apps and continue to explore feature improvements that reflect the diverse needs of users. Another significant limitation of this study is its limited generalizability to older adults with IBD. Since the participants were relatively young and digitally proficient, the usability findings may not fully represent the experiences or challenges faced by older patients, who may have lower digital literacy or different usage preferences. Future research should include a more diverse age group, particularly older adults, to assess usability and adoption across age-related digital disparities.

### Future direction

Future research should develop advanced features such as PRO data-based symptom prediction, dietary recommendations based on the relationship between medication, diet, and symptoms, AI chatbot consultations, and enhancing interoperability with clinical decision support systems. Additionally, studies validating individualized interventions'effectiveness based on patient-reported outcomes are needed. This would enable the evaluation of how communication and information are shared between patients and clinical experts, based on reliable data recorded in the app, and how it can impact patient health management.

Furthermore, studies exploring the impact of nurse-led mobile health interventions on healthcare app adherence and healthy lifestyle choices are suggested. These studies would help demonstrate the effectiveness of digital interventions and digital nursing, contributing to the broader adoption and use of digital healthcare solutions in clinical settings.

Therefore, future studies should conduct larger clinical trials and randomized controlled trials to thoroughly analyze the long-term effectiveness of digital healthcare apps and explore improvements in user-centered functionality.

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-025-13323-2.

Supplementary Material 1

Supplementary Material 2

### Authors' contributions

MJ (First Author) contributed to the overall study design, data collection, usability testing, and manuscript writing. She played a key role in conceptualizing the research and analyzing the study results. JS & JH (Corresponding Authors) supervised the research, provided expert guidance on study design and data interpretation, and reviewed and edited the manuscript. NG (Co-Author) contributed to literature review, data analysis, and participant recruitment for the study. JH & HS (Co-Authors) were responsible for developing the"WITH-Jang"digital healthcare app, including its architecture, database, and interface, and provided technical insights during usability evaluations.

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### Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

This study was approved by the Institutional Review Board (IRB) of Severance Hospital, Yonsei University Health System, Seoul, Republic of Korea (IRB No. 4–2023-1147), and all participants provided written informed consent before participation. The study was conducted in accordance with the Declaration of Helsinki.

### Consent for publication

None declared.

### Competing interests

The authors declare no competing interests.

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## Publisher's Note